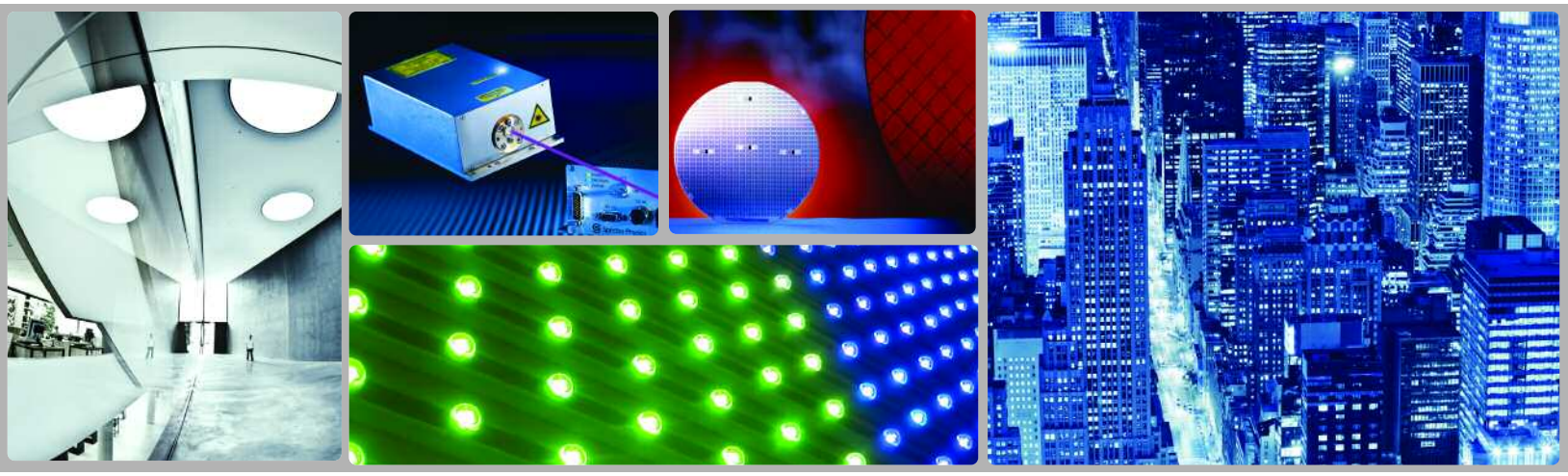
LED Scribing

Lighting the Way Forward



Solutions to **Make, Manage and Measure Light**[SM]

Newport
Experience | Solutions

Spectra-Physics
A Division of Newport Corporation

"The Department is eager to advance and accelerate research and development in this cutting-edge technology because solid-state lighting has the potential to more than double the efficiency of lighting systems, significantly reduce our carbon footprint and transform the built environment. Increasing energy efficiency across all sectors is a critical component of the President's comprehensive strategy to commercialize and deploy advanced technologies to meet our future energy needs in a way that encourages economic growth, enhances energy security and addresses the serious challenge of global climate change."

Alexander Karsner - U.S. Department of Energy Assistant Secretary for Energy Efficiency and Renewable Energy

LEDs for Illumination – A Bright New Future

The green movement, energy conservation and global warming have made the world aware of the need for more energy efficient lighting alternatives. The range of applications for high-brightness LEDs continues to expand. Laser scribing of wafers used to make LEDs is helping lead the way for great advancements in the area of optoelectronic devices used in LCD backlighting for cell phones, televisions, and touch screen displays. Most exciting is the advent of white LEDs for illumination.

Currently, about 12 billion electric lights on the planet use incandescent bulbs, or about 40,000 trillion lumen-hours per year. This takes a lot of fuel: the equivalent of nearly a billion tons of coal annually. In the United States alone, lighting uses the equivalent of 50% of the energy used by all cars on American roads. Recent tests by the US Department of Energy on lighting in showcase homes in Oregon demonstrated that LED-based lighting saved around 80% of electricity costs when compared with conventional incandescent or halogen lamps.

As the market has grown, there has been strong demand for improved throughput and yield ratios in LED production. Laser processing has rapidly become more popular, and it is now the industry standard for processing wafers for use in high-brightness LEDs.

Laser scribing LED wafers improves yield by creating much narrower scribe lines than traditional mechanical scribing. Laser scribing is a non-contact process that reduces micro-cracking and damage to the wafer substrate. This allows the LED devices to be much more closely spaced, improving both yield and throughput, and improves the long term reliability of the LED devices.

The high peak power and excellent beam quality of Spectra-Physics lasers are ideal for scribing as they result in cleaner scribe lines, higher throughput, and higher brightness of the LED devices.

Advantages to Laser Scribing

- Ability to cleanly scribe hard or brittle materials
- Non-contact process with a low cost of operation
- Reduced chipping, micro-cracking, and de-lamination
- Narrow cut widths enable more parts per wafer
- Reduced micro-cracking improves long term reliability of LED devices
- Wider process tolerance means more robust, reliable manufacturing at a lower cost

An Overview of LED Scribing

Single-crystal sapphire and gallium nitride (GaN) are hard materials (with a tensile strength approaching steel) that can be difficult to cut into individual LED devices. Traditional mechanical saws produce the undesirable effects of chipping, micro-cracking, and de-lamination as they cut through these materials. Saws have wide cut widths and require additional space between the LED devices due to micro-cracking which negatively impacts the yield and throughput.

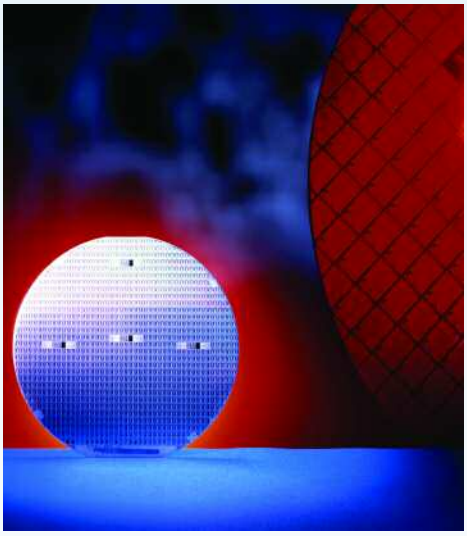
Alternatively, lasers are used in a non-contact process to first create a very narrow scribe line. This allows the wafers to then be broken into individual LED devices. The laser is tightly focused on the wafer substrate, ablating material to create a narrow scribe line between the active devices. Lasers are especially advantageous for scribing GaAs and other brittle compound semiconductor wafer materials. Typically, a scribe depth of 1/3 to 1/2 the substrate thickness is required to obtain a clean break. The need for generating both narrow and deep scribe lines at a high speed requires short pulse width, high beam quality, high peak power, and high repetition rate from the laser.

Laser scribing LED wafers is a challenge since the material is relatively transparent through the visible portion of the electromagnetic spectrum. GaN is transparent below 365 nm, and sapphire is semi-transparent above 177 nm. Thus frequency tripled (355 nm) and frequency quadrupled (266 nm) diode-pumped solid state (DPSS) Q-switched lasers are the best choice for LED scribing. While excimer lasers are also available in this wavelength range, DPSS lasers have much smaller footprint and can achieve much narrower cut widths and require far less maintenance.

By reducing micro-cracking and crack propagation, laser scribing allows the LED devices to be much more closely spaced, improving both yield and throughput. Because there might typically be more than 20,000 discrete LED devices on a single 2-inch wafer, cut width critically impacts yield. Reducing micro-cracking during the die separation process has also been shown to improve the long term reliability of the LED devices. Yield is improved with laser scribing by reducing wafer breakage. The speed of the laser scribe and break process is also much faster than traditional mechanical cutting. The wider process tolerance of lasers and the elimination of blade wear and breakage translate to a more robust highly reliable manufacturing process at a lower cost.

Key Market Requirements for DPSS Lasers

- Reliable
- High uptime
- Turnkey laser sources optimized for LED manufacturing
  – 266 nm DPSS lasers for front side scribing
  – 355 nm for backside scribing
- Global service and support network
- Short pulse width and high peak power for deeper scribing and to minimize thermal damage to circuits
- High beam quality for narrow scribe lines
- Laser supplier with experience and strong applications development support capabilities



The Spectra-Physics Advantage

- **High Uptime** – through superior product reliability, design, and support
- **Diode Life** – double the industry average
- **Support** – global service and support network servicing large installed base
- **Proven** – for 24/7 industrial use with an installed base of thousands of lasers
- **Short Pulse Width** – means higher peak energy and less heat affected zone
- **Excellent Beam Quality** – for narrow scribe lines
- **Better Pulse-to-Pulse Energy Stability** – translates to more precise scribe depth control
- **Experience** – state-of-the-art applications lab and our ability to accelerate the learning curve for laser scribing with your existing materials and processes

An Overview of Spectra-Physics

Spectra-Physics has long been recognized as the laser technology leader serving customers around the world. Spectra-Physics designs, develops, and manufactures premier lasers for a variety of commercial and industrial markets, including LED scribing.

Overall, the advantages of using lasers for LED scribing are clear, but the challenge comes in the variety of materials, thicknesses, speeds of each application. Spectra-Physics offers a wide range of tools for both scribing and dicing and remains the industry leader for innovative and high precision lasers such as the Tristar™, Navigator™, and HIPPO™ family of high-power nanosecond lasers, and the Vanguard™ series of picosecond lasers. When ultrafast (femtosecond) processing is required, the Solstice® laser provides 100 fs pulses in a fully-automated, rugged architecture, specifically designed for industrial applications.

When scribing LED substrates, the short pulse widths and high peak power of Spectra-Physics' lasers result in cleaner scribing, less displaced material, and less thermal damage to the substrate. Spectra-Physics also offers a depth of applications knowledge and experience to help maximize the efficiency of your process.

Our experience and innovation make our lasers stand out from the competition. The exclusive ProLite® diode pump modules are the industry leaders, allowing for twice the lifespan of diodes used in competitive lasers. Our EternAlign™ optical mounting technology ensures perfect optical alignment over the life of the laser.

Setting Spectra-Physics Q-switched lasers apart is a unique approach to harmonic conversion. Other key laser components such as diodes, fibers, shutter and output window are all easy to replace in the field, thus lowering inventory, shortening mean time to repair and increasing uptime. And, each laser comes with the confidence of having Newport's proven global service and support team.

Wavelength	Model	Average Power	Nominal Repetition Rate	Typical Pulse Width	Peak Power
355 nm	HIPPO 355-5	5 W	50 kHz	12 ns	8.3 kW
	Navigator 355-4	3.5 W	50 kHz	35 ns	5 kW
	Solstice	3.5 W	1, 5, 10 kHz	100 fs	35 GW
	Vanguard	2.5 W	80 MHz	12 ps	1 kW
	Tristar 355-1	1 W	100 kHz	25 ns	0.3 kW
266 nm	HIPPO 266-2	2 W	50 kHz	11 ns	3.6 kW

Newport Experience | Solutions

Spectra-Physics A Division of Newport Corporation

Newport Corporation, Global Headquarters
1791 Deere Avenue, Irvine, CA 92606, USA
www.newport.com
PHONE: 1-800-222-6440 1-949-863-3144 FAX: 1-949-253-1680 EMAIL: sales@newport.com
Complete listings for all global office locations are available online at www.newport.com/contact

	PHONE	EMAIL		PHONE	EMAIL
Belgium	+32-(0)0800-11 257	belgium@newport.com	Mtn. View, USA	+1-800-775-5273	sales@spectra-physics.com
China	+86-10-6267-0065	china@newport.com	Netherlands	+31-(0)30 6592111	netherlands@newport.com
France	+33-(0)1-60-91-68-68	france@newport.com	United Kingdom	+44-1235-432-710	uk@newport.com
Japan	+81-3-3794-5511	spectra-physics@splasers.co.jp	Germany / Austria / Switzerland	+49-(0)6151-708-0	germany@newport.com
Taiwan	+886 -(0)2-2508-4977	sales@newport.com.tw			

BR-09091